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**BEYOND THE MOUNTAINS:  
NUCLEAR WASTE TRANSPORTATION AND THE REDISCOVERY OF NEVADA**

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**ABSTRACT**

The authors review recent activities by the U.S. Department of Energy regarding potential selection of a preferred mode and route for transporting spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain repository site. Identification of the Caliente option as the preferred corridor for construction of a new rail line to Yucca Mountain will force DOE to rediscover key aspects of Nevada physical geography and stakeholder interests, factors and forces which will challenge DOE transportation planning. The authors believe that DOE should view the current situation as an opportunity to review State of Nevada recommendations regarding development of the Yucca Mountain transportation system.

**INTRODUCTION**

Just before Christmas, 2003, Dr. Margaret Chu, Director of the Office of Civilian Radioactive Waste Management (OCRWM), sent a letter to Nevada Governor Kenny Guinn. Dr. Chu notified the Governor that the U.S. Department of Energy (DOE) might soon make major decisions about transportation to Yucca Mountain. The letter reiterated that the DOE Final Environmental Impact Statement (FEIS) had “identified mostly rail as the preferred alternative transportation mode, both nationally and in Nevada, for shipments of spent nuclear fuel and high-level radioactive waste. ... If the Department adopts mostly rail as the transportation mode in Nevada, a rail line to connect the repository site at Yucca Mountain to an existing rail line in the State of Nevada would need to be constructed.” (1)

The apparent purpose of the letter was to announce the selection of a rail route to Yucca Mountain: “At this time, the Department is identifying Caliente as our preferred corridor, with the Carlin corridor as the secondary preference. ... Our preference for Caliente takes into consideration its more remote location, and the diminished likelihood of land use conflicts.” The Caliente corridor is 319 miles long (513 kilometers), and traverses Lincoln, Nye, and Esmeralda Counties. The letter then clarified that a formal corridor selection had not yet occurred: “If the Department adopts the mostly rail mode, a Record of Decision selecting a rail corridor could be issued no sooner than 30 days after publication of this preference announcement in the Federal Register. DOE will also issue a Notice of Intent in the Federal Register before initiating preparation of a rail alignment environmental impact statement.” Dr. Chu concluded: “If there are any facts or views you wish to bring to our attention bearing on our preference for the Caliente corridor, or the ultimate selection of a rail corridor, I would appreciate hearing from you.” (1)

On December 29, 2003, DOE published a “Notice of the Preferred Nevada Rail Corridor” in the **Federal Register**. The Notice essentially repeated the information in Dr. Chu’s letter to Governor Guinn, but added a potential timeframe for action: “If the Department selects a rail corridor, DOE will issue a Notice of Intent in the **Federal Register** to initiate the preparation of a rail alignment EIS under the National Environmental Policy Act (NEPA) to consider alternative alignments within the selected corridor for construction of a rail line. Under this scenario, the Department would anticipate holding public scoping meetings in early-to-mid February, 2004. The exact date, time, and locations of the meetings would be announced in the Notice of Intent.” (2)

Early-to-mid February, 2004, came and went, with no further DOE announcements. Nevadans, however, have already been forced to respond to a potential DOE rail corridor selection, because DOE has requested

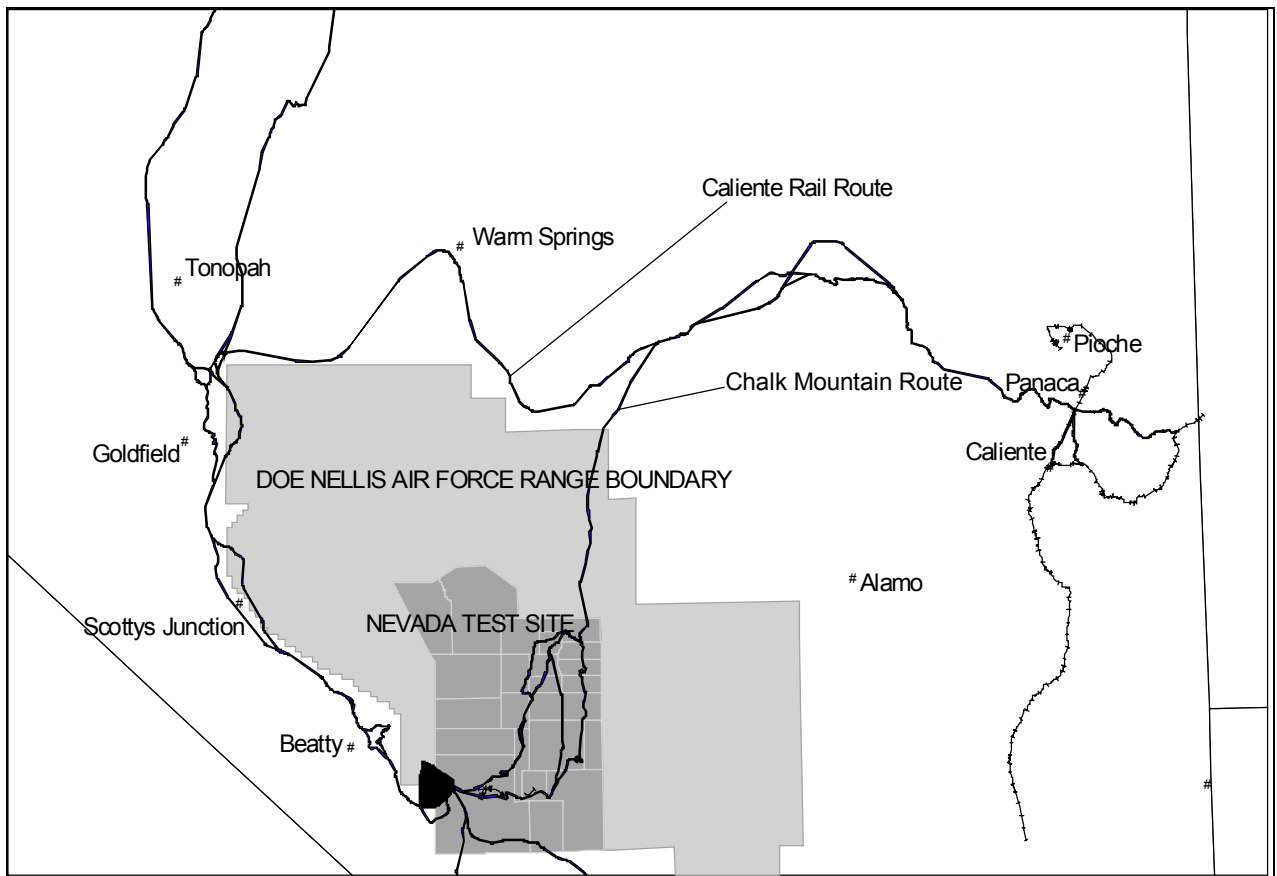
that the Bureau of Land Management (BLM) withdraw 308,600 acres of public land along the Caliente corridor “from surface entry and mining for a period of 20 years to evaluate the land for the potential construction, operation, and maintenance of a branch rail line” to Yucca Mountain. The BLM has already segregated these lands “for up to 2 years while various studies and analyses are made to support a final decision on the withdrawal action.”(3)

As of February 29, 2004, DOE has not formally selected a preferred transportation mode nationally or in Nevada, nor has DOE formally selected a preferred corridor for rail construction in Nevada. The Draft EIS, the Final EIS, and certain EIS references, remain the primary sources of information on the Yucca Mountain transportation options DOE is considering. (4,5) The Nevada Agency for Nuclear Projects has documented major deficiencies in these DOE NEPA documents, and has argued that DOE must reassess its transportation options through the NEPA process, before proceeding to implement any major transportation decisions. (6,7,8,9)

The authors believe that DOE should view the current situation as an opportunity to rediscover certain aspects of Nevada transportation mode and route selection, and to rediscover Nevada’s transportation system recommendations. In this paper we address only a few of the corridor-specific issues: physical geography, Native American interests, ranching interests, and impacts on Las Vegas. Many other issues, such as impacts on biological resources, water resources, and military operations, will need to be addressed as part of the BLM land withdrawal process, and as part of the scoping process for a rail alignment EIS, if DOE proceeds with the Caliente rail corridor selection.

#### **REDISCOVERING NEVADA: PHYSICAL GEOGRAPHY**

The Caliente corridor preference decision will force DOE to rediscover the physical geography of Nevada. First and foremost, DOE will rediscover Nevada’s mountains. Nevada doesn’t have the highest mountains, but it may have the most mountains. One popular tourist guidebook claims that Nevada has more than 300 mountain ranges, many with peaks above 7,500 feet, and several with peaks above 10,000 feet. (10)



**Fig. 1. Caliente and Caliente-Chalk Mountain Corridors**

Figure 1 shows the Caliente and Caliente-Chalk Mountain corridors. The Caliente corridor is located primarily within the Basin and Range Region of Nevada, which is divided by more than 150 North-South mountain ranges. (11) These North-South mountain ranges pose a considerable challenge to East-West railroad building. The original DOE Caliente rail route, which followed existing highways U.S. 93 and S.R. 375, was moved 40 miles north in 1992, in large part to avoid Hancock Summit through the Pahrnagat Range and Coyote Summit through the Timpahute Range. (12) Figure 2 shows Hancock Summit.



**Fig. 2. Hancock Summit**

The first hundred miles of the current DOE Caliente corridor must cross, skirt, or dodge the Delamar Mountains, the Chief Range, the Highland Range, the North Pahroc Range, the Seaman Range, the Golden Gate Range, and the Worthington Mountains. Figure 3 shows Bennett Pass, the first major mountain crossing along the corridor. The second hundred miles of the corridor must cross the Quinn Canyon Range, slip between the Groom and Belted Ranges to the South and the Revielle Range to the North, traverse Warm Springs Summit (elevation 6,293 feet) between the Kawich and Hot Creek Ranges, and turn South to avoid Sugarloaf Mountain and the Monitor Hills. In its final 119 miles, the primary corridor must cross into the Nellis Air Force Ranges to avoid mountains and hills near Goldfield, and snake along the Nellis boundary to avoid Stonewall Mountain, Pahute Mesa, Oasis Mountain and Bare Mountain before arriving at the southern extent of Yucca Mountain.



**Fig. 3. Bennett Pass**

DOE has not to our knowledge revealed a conceptual plan for a specific rail alignment within the current Caliente corridor. A conceptual plan and vertical profile are required for evaluation of feasibility and construction cost. A preliminary analysis of the first 100 miles, prepared for this paper based on previous DOE and Nevada studies, (6,7,8,12) indicates that DOE railroad construction and operation will be challenged by the rugged topography. The first four mountain crossing segments, ranging in length from 7 miles to more than 20 miles, would involve ascending and descending from valley elevations of 4,600 to 5,200 feet, to summit elevations of 5,400 to 6,100 feet. Figure 4 shows Timber Mountain Pass, the highest summit crossed in the first 100 miles. While a specific alignment has not yet been selected, almost any alignment within the proposed corridor will require grades of 1.3 percent to 2.4 percent for 75 of the first 100 miles, even after extensive cut-and-fill activity to limit maximum grades to 2.5 percent. DOE should expect to encounter similar conditions at other locations along the remaining 219 miles.





**Fig. 4. Timber Mountain Pass**

Caliente was the second-longest (319 miles), and most expensive (\$880 million), of five rail access options identified by DOE. Carlin, the longest option, was 323 miles. Either of these routes would be considerably longer than the 113-mile Orin Line constructed by the Burlington Northern to access the Wyoming Powder River Basin coal fields in the 1970s. The Orin Line was the longest new track construction effort in the United States since the 1930s. (8) By way of further comparison, the Caliente route would be longer than the distance from Washington to New York (204 miles); St Louis to Chicago (259 miles); or London to Paris (213 miles). (13)

#### **REDISCOVERING NEVADA: NATIVE AMERICAN INTERESTS**

The Caliente corridor preference decision will force DOE to rediscover potential conflicts with Native American interests. Native American concerns have been documented by more than 15 years of studies and analyses sponsored by the Nevada Agency for Nuclear Projects, and are summarized in the Agency's summary impact report. The proposed repository location at Yucca Mountain is a very old border between the Western Shoshone and the Southern Paiute. In the immediate area are several federally recognized tribes and their reservation communities, as well as other urban and rural Native American residents, and organizations such as the Western Shoshone National Council. Most Native Americans in Nevada do not want the disturbance of cultural resources that they see as the inevitable outcome of the Yucca Mountain project. (7)

The entire Caliente corridor lies within lands claimed by the Western Shoshone Nation under the Ruby Valley Treaty. DOE has acknowledged that the corridor may cross traditional holy lands important to the Southern Paiute, Western Shoshone, and Owens Valley Paiute and Shoshone peoples. The Bonnie Claire alternate portion of the Caliente corridor near Scotty's Junction would traverse lands held in trust for the

Timbisha Shoshone Tribe. (5,6,7,8) According to DOE, “archaeological surveys have been conducted in less than 1 percent” of the total area for the Caliente corridor. [FEIS, 3-151]

Rail shipments to Caliente from California on the existing Union Pacific mainline would traverse almost the entire length of the Moapa River Indian Reservation. All of the truck shipments required under the DOE mostly rail scenario would cross the Moapa River Indian Reservation on I-15 and the Las Vegas Paiute Reservation on U.S. 95. (7)

Tribes potentially affected by transportation to Yucca Mountain have identified the following concerns: DOE & BIA failure to formally recognize affected tribe status and provide financial and technical assistance; protection of religious and cultural sites, and plants and animals, both on and off reservations; implications of rail spur right-of-way acquisition for Western Shoshone land claims (Ruby Valley Treaty); cultural implications of possible radiological contamination and cleanup activities on tribal lands; stigma impacts on tribal businesses; tribal authority to regulate shipments across reservation lands, including pre-notification and monitoring; and tribal roles in emergency response planning and training. (7)

### **REDISCOVERING NEVADA: RANCHING OPERATIONS**

The Caliente corridor preference decision will force DOE to rediscover potential conflicts with Nevada ranching operations. Prior to the DOE corridor preference announcement and proposed BLM land withdrawal, ranching interests along the corridor in Lincoln and Nye Counties had, with few exceptions, not been major participants in the public discussions about transportation access. The Caliente corridor would directly impact ranching operations in Meadow Valley, Reveille Valley, Oasis Valley, and other areas. Since publication of the DOE and BLM notices in December 2003, ranchers have begun to express strong opposition. (14)

DOE corridor preference criteria, specifically avoidance of privately-owned land, ignore the realities of ranching in Nevada. Land ownership does not accurately reflect land-use. Most ranching operations are based upon a combination of privately owned fee land and grazing leases on publicly owned lands. Splitting an existing operation with a rail line that will limit access to the leased land can have significant adverse effects on the operation of the ranch. If the rail line is fenced, the splitting of ranching operations will be perhaps the most significant impact. The rail line will bisect many local roads, and grade separated crossings will be limited to major roads. (7)

Ranching operations will be the most affected by the barrier to movements created by the proposed rail line. Box culverts and bridges are commonly used to provide underpasses under railroad tracks for the movement of livestock and equipment. Underpasses will be limited to locations where underpasses can be constructed based on the topography and the profile of the proposed rail line. The degree of impact is a combination of the proposed at road crossings (either at grade or grade separated) and proposed drainage structures. A preliminary Agency analysis for the Caliente corridor found the average distance between potential crossing locations is 19.2 miles. The longest distance is 39 miles. (7)

The FEIS impact assessment was limited to assessing impacts within a set distance (60 meters and 400 meters, or 200 feet and one-quarter mile) of the identified corridor. Railroad yards, borrow areas, areas for disposal of surplus fill, staging areas, construction camps, lay down areas, access roads to construction initiation points, and other construction and maintenance activities will result in impacts on ranching outside of the identified corridors. (7)

### **REDISCOVERING NEVADA: LAS VEGAS**

The Caliente corridor preference decision will force DOE to rediscover the controversy about shipments of spent nuclear fuel and high-level radioactive waste through downtown Las Vegas. DOE selection of the Caliente rail corridor would directly impact downtown Las Vegas. Additionally, truck shipments required under the mostly rail scenario would impact the Las Vegas metropolitan area. (6,7,8)

The FEIS estimated DOE would make 9,646 rail cask-shipments to Yucca Mountain over 24 years. The FEIS assumed that 660 rail cask-shipments (about 7 percent) would enter Nevada from California, and

travel to Caliente via the Union Pacific Railroad mainline through Las Vegas. DOE assumed that the vast majority of rail shipments from the East (about 93 percent of the rail total) would use the Union Pacific mainlines from Chicago or Kansas City, via Gibbon, Nebraska, and Cheyenne, Wyoming, entering Nevada from Utah. [FEIS, Pp. J-140 to J-186]

The actual number of rail-cask shipments to Caliente through Las Vegas could be as high as 8,564 over 24 years, or about 89 percent. DOE current policy is that rail carriers will determine the routes used for shipments to Yucca Mountain. Alternative cross-country rail routes are available, and a number of factors could result in the vast majority of shipments from the East traveling to Nevada on the Burlington Northern-Santa Fe or Union Pacific routes across Texas, New Mexico, Arizona, and California. All rail shipments to Yucca Mountain, except those from the Pacific Northwest and Idaho, could therefore travel to Caliente through downtown Las Vegas under credible alternative routing scenarios. (15)

Many thousands of Las Vegas residents live and work near this potential rail route to Yucca Mountain via Caliente. The Union Pacific mainline between Apex Siding on the North and Arden Siding on the South is about 36 miles long. According to the 2000 Census, more than 39,000 people reside within one-half mile of the rail line. A number of large hotel-casinos are located within one-half mile also. When the resident population is combined with the school population, estimated average daily workers, and estimated hotel/casino guests, the average daily exposed population within one-half mile of the routes is currently about 86,000. (8)

If DOE formally selects Caliente as the preferred corridor to Yucca Mountain, tens of thousands of Clark County residents will be affected by the shipments. Moreover, these shipments could continue for a period of four decades or more. The potential for large-scale rail shipments through Las Vegas is a major concern for the State of Nevada, Clark County, and the Cities of Las Vegas and North Las Vegas. In addition to the potential impacts on residents, the proximity of the Union Pacific mainline to the world-famous Las Vegas Strip and to other major commercial properties create truly unique local impact conditions.

Additionally, the FEIS estimates 1,079 legal-weight truck shipments over 24 years for the mostly rail scenario. Under current DOE highway routing preferences, all of the truck shipments to Yucca Mountain would travel through the Las Vegas metropolitan area on I-15, I-215, and U.S. 95. [FEIS, Pp.2-49, J-186]

#### **REDISCOVERING NEVADA RECOMMENDATIONS: ROUTINE RADIATION EXPOSURES**

The State of Nevada is concerned about the construction of a high-level nuclear waste repository at Yucca Mountain, including the routine radiation exposures during incident-free transportation of spent nuclear fuel and high-level radioactive waste to the potential repository. These concerns derive from Nevada's experience with nuclear weapons testing at the Nevada Test Site and federal stewardship of approximately 87% of the state's land area. The combined exposures to radiation and Federal decision-making have created a political culture in Nevada that is skeptical of large Federal actions and eager to believe the worst about major Federal activities and their proponents. These concerns have been forcefully expressed by more than 15 years of studies and analyses sponsored by the Nevada Agency for Nuclear Projects. (7)

NRC regulations allow shipping casks to emit a small amount of radiation during routine operations (1,000 mrem/hr at the cask surface and 10 mrem/hr 2 meters from the cask surface). The dose rate allowed under NRC regulations results in near-cask exposures of about 2.5 mrem per hour at 5 meters (16 feet), in measurable exposures (less than 0.2 mrem per hour) at 30 meters (98 feet), and calculated exposures (less than 0.0002 mrem per hour) at 800 meters (one-half mile) from the cask surface. [FEIS, p. J-38]

DOE acknowledges that cumulative routine radiation from shipping casks could pose a health threat to certain transportation workers. DOE proposes to control these risks by restricting work hours and doses for certain jobs. [FEIS, Pp. J-44 to J-45] DOE concludes that members of the general public would not receive significant doses from passing trucks and trains. DOE concludes that even the maximally exposed members



of the public – a service station attendant, a resident near a rail yard, or a motorist stuck next to a truck cask in a traffic jam – would not suffer significant adverse health effects. [FEIS, Tables 6-9 & 6-12]

Studies prepared for the Agency have found that routine transportation radiation exposures could result in higher doses, both to workers and to members of the public, and in more significant health effects, than estimated by DOE. Moreover, the very fact that these exposures would occur may cause adverse impacts even though the dose levels are well below the established thresholds for cancer and other health effects. (16,17,18,19)

Agency-sponsored studies have found that radiation possesses some unique characteristics as a hazard. One Nevada researcher has grouped these characteristics into the categories of dread, exposure, and familiarity. This paradigm of “riskiness,” now widely adopted in the hazards research field, argues that radiation may be riskier than other hazards because people perceive the risk to be involuntary and uncontrollable (dread). It is reasonable to expect that the public will believe that a large number of people will be exposed to the radiation and that it is a hazard with which they are unfamiliar. Unique local conditions along some potential routes to Yucca Mountain could create elevated radiation exposure zones on private properties, and could constitute at least a ‘nuisance’ or even an actual ‘taking’ of property rights, both in terms of lost value and involuntary assignment of risk of radiological exposure. (7)

To help study and mitigate such risks, the Nevada Agency for Nuclear Projects has recommended to DOE the following measures to manage transportation routine radiation impacts:

1. Reassess potential doses to maximally exposed workers and members of the public.
2. Use more conservative dose conversion factors for estimating latent cancer fatalities (LCF's).
3. Consider health effects other than LCF's, specifically genetic and teratogenic risks.
4. Adopt the ALARA principle on a system-wide basis before proceeding to cask procurement.
5. Ship oldest spent fuel assemblies first, which could result in a potential 20 to 50 percent reduction in dose rate.
6. Assess unique local conditions along potential highway and rail routes in Nevada and identify implications for property rights and values.

#### REDISCOVERING NEVADA RECOMMENDATIONS: SEVERE ACCIDENTS

The State of Nevada is concerned about severe accidents during transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain. These concerns reflect Nevada's experience with transportation accidents and natural disasters, especially those involving rail transport, over the past century. These concerns also reflect more than 15 years of studies and analyses sponsored by the Nevada Agency for Nuclear Projects.

The State particularly disagrees with the FEIS conclusion that the maximum reasonably foreseeable accident scenarios for Nevada are the same as for national transportation. Unique local conditions require special consideration of truck and rail accidents involving commercial and military explosives; massive infrastructure failures resulting from severe earthquakes or floods; and a rail or truck cask involved in an accident with a military aircraft carrying live munitions. (6,7)

NRC regulations specify rigorous accident performance standards for spent fuel shipping casks. NRC does not require full-scale physical testing to demonstrate compliance with these regulations. NRC has proposed demonstration testing of one truck cask and one rail cask as part of the Package Performance Study (PPS). The State of Nevada has recommended an alternative approach to cask testing. (20) Nevada also recommends greater involvement by the Federal Railroad Administration in development of PPS testing protocols. Because of the extremely heavy weight of the new cask-railcar combinations (455,000 lbs as opposed to 255,000 lbs for a normal railcar), NRC should not assume that existing data reflect the type, severity, and frequency of accidents that may occur with the new railcars.

The Nevada Agency for Nuclear Projects has recommended to DOE and NRC the following measures for full-scale cask testing:

1. A meaningful stakeholder role in development of testing protocols, selection of test facilities, and input on personnel.
2. Full-scale regulatory testing (sequential drop, puncture, fire, and immersion) prior to NRC certification, or DOE procurement, of all cask designs used for shipments to Yucca Mountain.
3. Additional testing (casks, components, models) and computer simulations to determine cask performance in extra-regulatory accidents and to determine failure thresholds.
4. Reevaluation of the Modal Study findings, and if appropriate, revision of NRC cask performance standards.
5. Evaluation of the costs and benefits of destructive testing of a randomly-selected production model cask.

DOE acknowledges that a very severe highway or rail accident could release radioactive materials from a shipping cask, resulting in radiation exposures to members of the public and latent cancer fatalities (LCFs) among the exposed population. In the Draft EIS, DOE evaluated a "maximum reasonably foreseeable accident scenario" involving a rail accident at a generic urban location, resulting in a collective population dose of 61,000 person-rem and about 31 latent cancer fatalities. [DEIS, p. 6-33] In the Final EIS, DOE used an alternative methodology for consequence analysis, (21) and reduced the estimated rail accident consequences to a collective dose of 9,900 person-rem and 5 latent cancer fatalities. [FEIS, Pp. 6-45 to 6-47, 6-49 to 6-50] The FEIS states that clean-up costs following a worst-case transportation accident could reach \$10 billion. [FEIS, J-72 to J-74]

Studies prepared for the Nevada Agency for Nuclear Projects have estimated the consequences of credible worst case truck and rail accidents at representative urban and rural locations along potential Nevada highway routes. A Nevada-sponsored study also examined the consequences of a hypothetical spent fuel accident similar to the July 2001 Baltimore rail tunnel fire. These studies conclude that DOE has significantly underestimated the human health impacts of very severe transportation accidents, and that cleanup costs could exceed \$10 billion. (22,23,24,25)

The Nevada Agency for Nuclear Projects has recommended to DOE the following measures for comprehensive transportation risk management:

1. A comprehensive risk assessment (CRA) should cover all transportation system phases, events, and consequences as suggested by Golding and White (1990).
2. CRA calculates probabilities only where there is existing data, theories, and models that are sufficient to support use of rigorous quantitative methods, and uses sensitivity analysis to illustrate impacts of differing assumptions and variations in quality of data.
3. CRA should be used as a working risk management tool throughout the life cycle of the Yucca Mountain project, with ongoing public participation
4. CRA should be the basis of risk communication throughout life cycle of the Yucca Mountain project.

Comprehensive risk assessment is a precursor of a growing trend in risk analysis and regulation away from "point estimates" in which a single number is presented as a meaningful risk estimate. Instead, a range of possibilities is presented with an associated likelihood, when that likelihood may be estimated.

The Nevada Agency for Nuclear Projects has recommended to DOE the following measures for accident prevention and emergency response:

1. Maximize use of regional organizations such as Western Governors Association (WGA) and Western Interstate Energy Board (WIEB) for planning, implementation, and program evaluation.
2. Coordinate with relevant corridor Indian Tribes and local governments.
3. Develop comprehensive safety program modeled after WGA-State-DOE WIPP Transportation Program.
4. Adopt WIEB (September 1994) proposal for evaluation and final designation of preferred shipping routes.
5. Implement Section 180(c) for financial assistance to state, local, & tribal governments through rulemaking.

6. Revise DOE Plan for Privatization of Transportation Services to emphasize safety and public acceptance.

The Nevada Agency for Nuclear Projects has recommended to DOE the following measures for development of a preferred transportation system for all shipments to Yucca Mountain:

1. Develop dual purpose casks for at-reactor storage and transport.
2. As noted elsewhere, ship the oldest fuel assemblies first, that is, those with at least 20 years at-reactor cooling.
3. Adopt the transportation modality that makes maximum use of rail.
4. Make mandatory use of dedicated trains, special safety protocols, and special car designs as recommended by American Association of Railroads.
5. Insist that DOE and carriers make early identification of preferred cross-country mainline routes in consultation with stakeholders.
6. Encourage early involvement of corridor states and Indian Tribes, including financial assistance under Section 180(c), as part of the route selection process.

#### REDISCOVERING NEVADA RECOMMENDATIONS: TERRORISM AND SABOTAGE

The State of Nevada is concerned about terrorism and sabotage during transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain. These concerns reflect Nevada's experience with specific instances of terrorism and sabotage like the 1939 Harney rail disaster, an extortion bombing incident at a Nevada hotel, various anti-government attacks and bombings in Nevada, and recent revelations that Las Vegas was not only used as a staging area by Islamic terrorists, but that Las Vegas might be a primary and highly symbolic target for Islamic terrorists. These concerns are bolstered by DOE documents and relevant research on this subject sponsored by Nevada's Agency for Nuclear Projects. (7,26)

DOE acknowledges that shipping casks are vulnerable to terrorist attack and sabotage. DOE-sponsored research (27) indicates certain explosive devices could breach the wall of a cask, "leading to the dispersal of contaminants to the environment." A successful attack on a truck cask would release more radioactive materials than an attack on a rail cask. [DEIS, p. 6-33 to 6-34] DOE has estimated that a successful terrorist attack on a truck cask in an urban area would result in a population dose of 96,000 person-rem, and 48 latent cancer fatalities. [FEIS, Pp. 6-50 to 6-52] While the DOE did not specifically estimate cleanup costs after such an attack, cleanup requirements would likely be similar to a worst-case transportation accident.

Analyses prepared for the State of Nevada estimated terrorism or sabotage impacts would be considerably greater than even these DOE estimates. Nevada contractors replicated the DOE FEIS sabotage consequence analyses, using the RISKIND model for health effects and the RADTRAN model for economic impacts, the same average and maximum inventory release fractions, and a range of population densities and weather conditions.

The Nevada-sponsored study concluded that an attack on a GA-4 truck cask using a common military demolition device could cause 300 to 1,800 latent cancer fatalities, assuming 90% penetration by a single blast. Full perforation of the cask, likely to occur in an attack involving a state-of-the-art, anti-tank weapon, such as the TOW missile, could cause 3,000 to 18,000 latent cancer fatalities. Cleanup and recovery costs would exceed \$10 billion. (28,29,30,31,33)

Beyond attacking a cask with explosives, terrorists might commit radiological sabotage by causing a devastating transportation accident. Published terrorism risk assessments have not, to date, considered the possibility that an intentional, human-initiated event could disperse radioactive material from a shipping cask, let alone consider the implications of a combined bombing and accident tactic. Concerns about terrorism have prompted calls for reappraisals of risk management and assessment practice in order to better understand risk.

Well before the terrorist suicide attacks of September 11, 2001, concern about the terrorist threat to repository shipments led Nevada's Attorney General to file a petition for rulemaking with the NRC in June 1999. In the petition, Nevada documented the vulnerability of shipping casks to high-energy explosive devices. Nevada also submitted evidence that shipments to a national repository would be dramatically different from past shipments in the United States, and that these differences would create greater opportunities for terrorist attacks and sabotage. The petition requested a general strengthening of the current transportation safeguards regulations and a comprehensive reexamination of the consequences of radiological sabotage. (32)

The NRC published Nevada's petition (Docket PRM-73-10) in the *Federal Register* on September 15, 1999, and accepted public comments through February 2000. The Western Governor's Association endorsed Nevada's petition on behalf of 18 western States. Five other states (LA, MI, OK, VA, and WV) also endorsed all or part of the petition. Four years after the close of the comment period, and more than two years after the 9/11 attacks, the NRC has still not officially responded to Nevada's petition.

The State of Nevada has summarized its terrorism and sabotage concerns in two main areas: Pre-September 11, 2001 concerns (prevention and mitigation regulations and risk assessment protocols); and post-September 11, 2001 concerns (emerging factors relative to terrorism and new requirements for risk assessments). These are summarized below.

The State of Nevada has petitioned the NRC to amend the following regulations to better deter, prevent and mitigate consequences of radiological sabotage against spent fuel shipments:

1. Reexamine Design Basis Threat for Radiological Sabotage - 10 C.F.R. 73.1(a)(1) with the intention of creating a transportation specific model at least as robust as the fixed site model.
2. Expand Definition of "Radiological Sabotage" - 10 C.F.R. 73.2.
3. Strengthen Requirements for Advance Approval of Routes - 10 C.F.R. 73.37(b)(7).
4. Adopt New Requirements for Planning and Scheduling - 10 C.F.R. 73.37(b)(8).
5. Strengthen Escort Requirements for Shipments by Road - 10 C.F.R. 73.37(c).
6. Strengthen Escort Requirements for Shipments by Rail - 10 C.F.R. 73.37(d).
7. Adopt New Regulation to Require that All Rail Shipments be made in Dedicated Trains - 10 C.F.R. 73.37(d).

The State of Nevada has petitioned the NRC to conduct a comprehensive assessment of consequences of terrorist attacks that have the capability for radiological sabotage:

1. Assess attacks against transportation infrastructure used during nuclear waste shipments.
2. Assess attacks involving capture of a nuclear waste shipment and use of high energy explosives against a cask or casks.
3. Assess direct attacks upon a nuclear waste shipping cask or casks using antitank missiles or other military weapons.

In light of lessons learned from 9/11, the State of Nevada recommends that DOE and NRC transportation terrorism risk assessments consider such emerging factors as:

1. Attacks involving multiple weapons and/or combinations of weapons designed to maximize release and dispersal of radioactive materials.
2. Attacks involving coordinated use of hijacked vehicles, including tanker trucks.
3. Attacks involving large groups of well-trained adversaries, including suicide attacks.
4. Attacks involving terrorist infiltration of trucking and railroad companies (or what is known as the active insider).
5. Attacks at locations with a highly symbolic social, political, or economic value.

In light of lessons learned from 9/11, the State of Nevada recommends that DOE and NRC transportation terrorism risk assessments address:

1. Standard socioeconomic impacts, including cleanup and disposal costs and opportunity costs to affected individuals and business.

2. Economic losses resulting from public perceptions of risk and stigma effects.
3. Impacts on emergency responders and recovery workers, including long term monitoring, care, and health benefits for these first responders.

## CONCLUSIONS

DOE plans are currently uncertain regarding selection of a preferred mode and route for transporting spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain repository site. The State of Nevada believes that DOE must reassess its transportation options through the NEPA process, before proceeding to implement any major transportation decisions. DOE identification of the Caliente option as the preferred corridor for construction of a new rail line, coupled with the DOE request for BLM land withdrawal along the proposed corridor, will force DOE to rediscover key aspects of Nevada physical geography and stakeholder interests

DOE should view the current situation as an opportunity to rediscover certain aspects of Nevada transportation mode and route selection, including physical geography, Native American interests, ranching interests, and impacts on Las Vegas. Many other issues, such as impacts on biological resources, water resources, and military operations, will need to be addressed as part of the BLM land withdrawal process, and as part of the scoping process for a rail alignment EIS, if DOE proceeds with the Caliente rail corridor selection. DOE should also view the current situation as an opportunity to rediscover Nevada's transportation system recommendations regarding routine radiation exposures, severe accidents, and terrorism and sabotage.

## REFERENCES

1. DOE, "Correspondence from M.S.Y. Chu, OCRWM Director, to The Honorable Kenny Guinn, Governor, The State of Nevada" (December 23, 2003).
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